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Household Perceptions about the Impacts of Climate Change on Food Security in the Mountainous Region of Nepal

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Abstract: This study tried to understand the mountainous households' perception of climate change and its impacts on food security in the Lamjung district of Nepal. The study attempted to find out changes in households food security and daily activities in the face of climate change for the last twenty years. The study started with the 150 household surveys along with participatory rural appraisal to understand the climate change perception of local people and its impact on dimensions of food security. Households expressed different levels of perception in terms of climate change on food security. The result shows that most of the mountainous households experienced increased temperature, less rainfall in winter, an increasing number of natural disasters and the emergence of insects for the last twenty years. They perceived the role of climate change in decreased crop production, decreased dairy products and increased household work. The situation of food security is likely to be more vulnerable to climate change in the future. It was also observed that households have been using different autonomous adaptation measures, such as high yielding crop varieties, enhanced irrigation systems and fertilizers, to cope with the changing climate. Finally, the study recommended policy instruments to enhance food security in the mountainous region amidst changing climate.

Keywords: climate change; perception; impacts; food security; mountain; adaptation; Nepal

1. Introduction

The Intergovernmental Panel on Climate Change (IPCC) 2014 report explains that climate change impacts are already visible, especially in developing countries like Nepal, which are more vulnerable due to their inability to cope with it [1]. It is anticipated that the increasing rate of the average temperature in the Himalayas will be greater than the global average [1,2]. The increasing temperatures may affect the timing and quantity of precipitation and change water availability [3]. Furthermore, with changes in precipitation patterns, there is a greater possibility of climate-induced disasters, such as landslides, floods and droughts. This may affect the agriculture sector and eventually food security.

Climate change and increasing numbers of natural disaster are directly impacting food security in several parts of the world. In the last decade, more than 200 million people were affected annually by natural disasters [4], which is seven times more than those affected by conflict. Frequent natural disasters due to changing climate make the global food system even worse, which is already in crisis for meeting basic demands. Almost 429 million people worldwide facing chronic hunger are from the Hindu Kush Himalayas (HKH) region countries [5]. Furthermore, several studies [2,6,7] have shown that severity of food insecurity in mountain areas is significantly higher than in plain areas.

The people living in the mountainous areas are highly vulnerable to food insecurity because of their subsistence agriculture, low productivity, poor infrastructure and transportation facilities,

lack of market access and vulnerability to natural hazards [8–10]. Mixed agro-livestock farming is the main source of livelihoods in the mountainous areas [2]. Nowadays, remittances received from out-migrated, small businesses, wage labor, tourism and the collection of medicinal plants and other herbs also contribute to livelihoods and food security [2]. However, in recent years, climatic and socio-economic factors have contributed to the depletion of the natural resources across the HKH region [9]. Changing precipitation patterns are exacerbating the vulnerability of mountain agriculture, which is mainly rain-fed. Mountain farmers are experiencing increasing numbers of natural disasters such as landslides and prolonged droughts, resulting in low productivity of agriculture and higher prevalence of food insecurity. In Nepal, for instance, the incidence of food poverty in mountain regions is 48% compared to 18% in the plain areas [2]. Similarly, in mountain areas of Pakistan, nearly 60% of the people are food insecure [11].

According to the IPCC's Fourth Assessment Report and other scientific studies [1], it is clearly understood that climate change has a direct impact on agriculture, livestock and fishing, especially in developing countries where people are living below the poverty line; and it will affect not only local, but also global food security [12]. Climate change can have serious impacts on the four dimensions of food security: food availability, food accessibility, food utilization and food system stability. Effects are already being felt in global food markets [8], and they are likely to be particularly significant in specific rural locations where crops fail and yields decline. Impacts will be felt in both rural and urban locations where supply chains are disrupted and market prices increase. Similarly, assets and livelihood opportunities are lost, purchasing power falls, human health is endangered and affected people are unable to cope. The possible impacts of climate change on food security have tended to be viewed with most concern in locations where rain-fed agriculture is still the primary source of food and income.

The Food and Agriculture Organization (FAO) [13] defines food security as a "situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life". This definition addresses the four aforementioned key components of food security [14]. Climate change affects food security in a complex way. A food system is vulnerable when one or more of the four components is uncertain and insecure. According to the FAO definition, climate change has a direct impact on food production systems through changes in agro-ecological conditions. It indirectly affects food distribution, accessibility and price, and it creates local food crises. For example, changing rainfall patterns due to climate change increase the possibility of floods in lowland areas and landslides at higher altitudes. Due to its heterogeneous topography, Nepal has a high risk of natural disasters such as glacial lake outburst floods (GLOFs), avalanches and landslides at higher altitudes, as well as floods in lower regions. The number of climate-related disasters and the number of people affected during the last 30 years are presented in Figure 1. A large number of the population was affected by floods followed by droughts and landslides between 1980 and 2014. Hence, mountainous countries such as Nepal are more vulnerable to climate change [15] and its effects on food security.

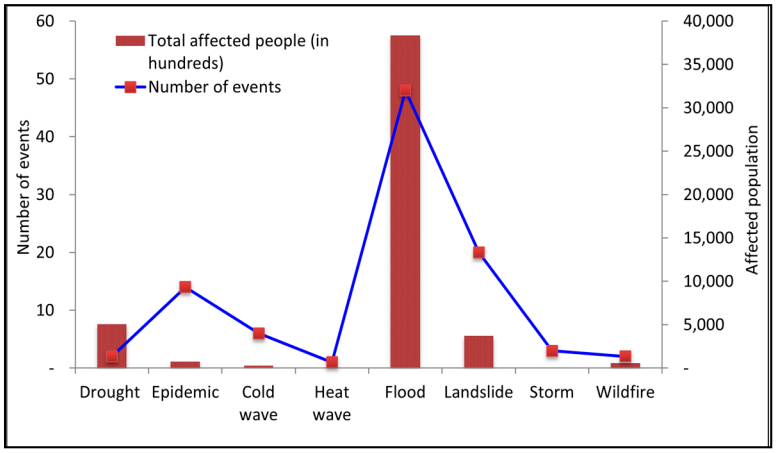

Figure 1. Number of climate-related natural disasters and affected people in Nepal from 1980 to 2014. Source: [16].

Several studies on the impacts of climate change on food security have focused on crop models, which indicate where yield might increase or decrease due to global warming [17–19]. However, the models do not consider the local household-level food security. Moreover, focusing solely on changes in crop yield ignores the important issue of food access, especially market-dependent, poor or food-insecure households. To systematically analyze the impacts of climate change on food security, it is important to integrate all four components of food security (i.e., food availability, access, utilization and stability). Several studies explain that increased incidences of erratic precipitation, landslides, floods and droughts have decreased agricultural production and deteriorated food security [2,20,21]. Therefore, this study explores whether these scientific findings are reflected in local people's perceptions of climate change and household food security.

Therefore, this study analyzes the impacts of climate change on the food security of mountainous households while considering all of the factors that contribute to food availability, accessibility and consumption patterns in the Lamjung district of Nepal. Possible measures are provided to mitigate the impact of climate change on food security in the region. Some of the main goals are:

1. To understand local people's perceptions of climate change.
2. To find the underlying causes of changes in food availability, accessibility and consumption.
3. To understand changes in the daily activities of local people.
4. To provide recommendations for policy makers to mitigate the impact of climate change on local food security.

2. Climate Change and Food Crisis in Nepal

Different views have been given about the food security situation of Nepal. Some literature works mentioned a serious problem of food security [7,22], while others report that Nepal has sufficient food to feed its population in a good harvest season [23,24]. The proper food balance sheet is yet not prepared by the government of Nepal, and only food grains are included in the food balance sheet prepared to judge the state of food availability; this shows food insecurity in Nepal. The Nepal Demographic and Health Survey (NDHS) 2011 states that only 49% of households (HHs) in Nepal are food secure and have access to food throughout the year [7]. This shows that half of the population is food insecure. According to the Food Balance Sheet of Nepal 2013, 33 out of 75 districts were estimated to be food deficient in that year [25]. Based on NDHS (2011), approximately 12% of HHs are mildly, 23% moderately and 16% severely food insecure. Rural households (46%) are less food secure compared to urban households (67%). Additionally, households in the highest wealth quintile are much more likely to be food secure (82%) than those in the lowest wealth quintile (18%) [9]. The report

prepared by the International Food Policy Research Institute (IFPRI) mentioned that the Global Hunger Index of Nepal in the year 2013 was 17.3, indicating a serious problem of food security. The underlying causes of food insecurity in Nepal are complex.

Due to the increasing population, increasing climate-induced calamities and uncertainty in agricultural production, Nepal has been considered a food deficit country since the 1990s. Changing temperatures and erratic rainfall patterns are affecting crop production in Nepal [26]. There has also been the observation of a loss of local crops and domestic animals, changes in cropping patterns, water scarcity due to water resources drying up and increasing incidences of diseases and pests [27]. Climate change accelerates the deterioration of food production and other livelihood assets, and persistent poverty and increasing population exacerbate food insecurity. According to the FAO (2002), the size of the food-insecure population increased from 3.5 million (19% of the population) to 5 million (23%) between 1995 and 2002.

More than 60% of the population depends on subsistence agriculture [28], and heavy dependence on agriculture makes Nepal's economy very sensitive to climate variability. Food production changed remarkably in 2007, with an overall reduction by 3.35% of cereals and other crops compared with 2001 [29]. There is great regional variation, and people in mountainous areas suffer more due to lack of access because of poor development infrastructure, such as road networks and warehouses to store food for food-lean seasons. In addition, crop yields have strong associations with the amount of rain received at the right time. The reduction of rice production in earlier years can be closely linked to the abnormal rainfall received in those years. Based on statistics until 2010, about 29.75% of agricultural land was irrigated [30], which leads to vulnerability, and up to 80% of the population could be affected badly by a change in precipitation [31].

In 2005, there was a 2% and 3.3% decrease in rice and wheat production due to the prolonged drought. Similarly in 2006, rice production decreased by 27–39% in Eastern Terai due to drought [32]. There was a significant reduction in the yield of winter crops due to severe sky overcast conditions, particularly in Nepal and the Indo-Gangetic plains of India, which lie south of the mountain region, between 1990 and 2000 [33]. The yield reduction in 1997–1998 ranged from 11% to 38% compared to the average of the preceding 10 years [34].

Households perceive both positive and negative impacts of climate change on crop production and food security. Dahal [35] mentioned the positive impacts of climate change in the high mountains. He explained that farmers were growing vegetables, such as cauliflower, cabbages, tomato and cucumber, that were not possible a few years back. Some researchers [36–38] emphasized that some of the most profound impacts of climate change over the coming years will be on agriculture and food systems. Additionally, the extent to which households have the capacity to respond to or adapt to these changes has critical implications for human development at the household, community, national and global level.

3. Study Area

This study was conducted in the three village development committees (VDCs) of Kunchha, Khudi and Ilampokhari of Lamjung district (Figure 2) to explore the households' perception on climate change and its impacts on food availability, accessibility, utilization and the daily activities of the households. Detailed information of the selected VDCs is given in Table 1. These case study sites are fairly representative of the mid-hill and mountain villages, as they have relatively high climate change issues and a high percentage of abandoned land, which has a high potential for agricultural production.

Table 1. Profile of research sites and households.

Factor Details	Kunchha	Khudi	Ilampokhari
Coordinates	28.14°N 84.34°E	28.40°N 84.31°E	28.18°N 84.59°E
Area	7.22 km^2	64.23 km^2	33.11 km^2
Access to district headquarter (Beshishahar)	14.4 km road network	5.4 km road network	21.6 km road network
Total population	1855	3401	2650
Population density	256.92 km^2	55.88 km^2	80.03 km^2
Total number of households	514	826	608
Family size (Lamjung = 3.99)	3.61	4.12	4.36
Landholding size (ha)	0.79	0.49	0.77
Household food sufficiency (months)	9.06	5.91	8.94
Average monthly income (Rs.)	15,430	15,740	10,080
Median age of the respondents	41.5	45	54

Source: Central bureau of statistics 2013 and field survey from 2014 to 2016.

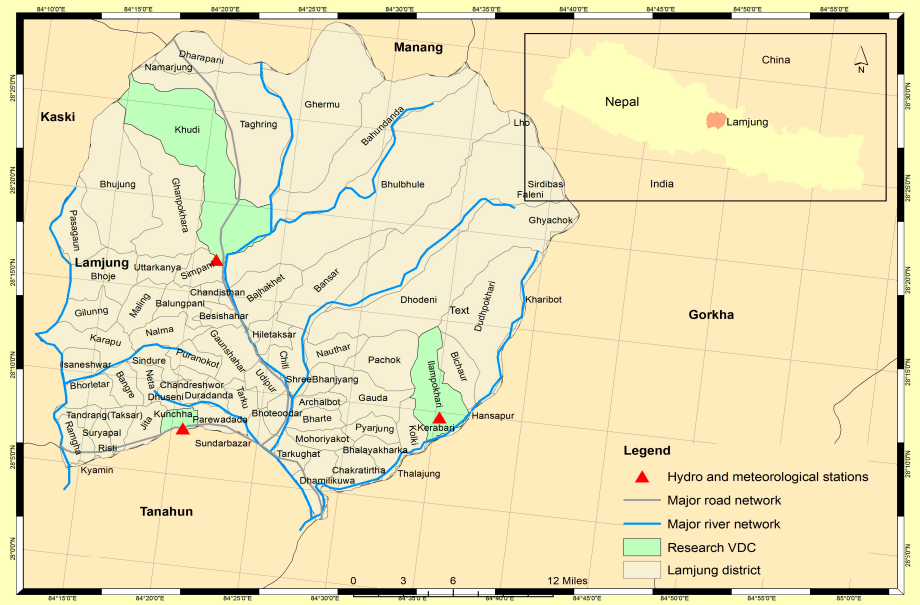

Figure 2. Map of the study area in Nepal. VDC: village development committees.

4. Methodology

The problems related to climate change and food security were conceptualized after an intensive literature review. A total of 150 respondents were selected through a systematic random sampling [39] method for a household survey. Each household head was interviewed to assess the impact of climate change on his/her food security. In addition, participatory exercises, such as focus group discussions (FGDs), local workshops and key informant interviews (KIIs), were performed. The results were analyzed using SPSS (IBM, 2015, Australia). The questions were focused broadly on issues of climate change; perceptions of local people of climate change; changes in crop production, food availability, accessibility and utilization; and changes in daily or economic activities to ensure food security. The data collected may not be a true representative of the whole district. Thus, caution is warranted for the generalization of these household-level results. The detailed procedure of the research methodology is given below.

4.1. Sampling Scheme for the Survey in Lamjung

Two-stage sampling was used with the district as the domain, the village as the primary sampling unit and the households as the secondary unit. Three VDCs were selected after consultation with local

stakeholders and based on the availability of hydrological meteorological stations. The three VDCs represent the three distinct characteristics of Lamjung: lower hills, middle hills and high mountains.

4.2. Selection of Households

The household lists of the VDC were obtained from each VDC office for the selection of 150 households in total. Each VDC has nine wards; so, 150 households were selected from the 27 wards.

Based on the numbers of households in each ward, six households were selected from each of the 15 high-density wards (90 households) and five households from each of the 12 low-density wards (60 households). The reference point was the VDC office. A random number n from 1 to 10 was drawn, and the n-th house to the right of the reference point was the first household interviewed. The next respondent was the tenth house to the right of the first respondent, and so on. If the household was not in the house or refused to be interviewed, then the next 10th house was interviewed.

4.3. Key Informant Interviews

A field survey in Lamjung was also conducted through key informant interviews. Each interview was designed to collect qualitative information on the community's perception of climate change and experience of extreme weather events, such as erratic rainfall, floods, droughts, landslides, and so on. It was conducted with a selected representative from the Nepal Agricultural Research Council (NARC), District Agricultural Development Office (DADO), Ministry of Agricultural Development (MOAD), Department of Hydrology and Meteorology (DHM) non-governmental organizations (NGOs), local leaders, women's groups and farmer groups.

4.4. Focus Group Discussions

After the research sites were finalized, a total of four FGDs were conducted in each VDC and one in district headquarters. A total of 24 people participated in the FGDs (six people in each FGD). The questions focused broadly on issues of climate variables, perceptions of climate change, changes in crop production, food availability, accessibility and utilization; and changes in daily activities to ensure food security. The participants were from various social backgrounds and occupations, such as farmers, local businessman and members of government organizations/non-governmental organizations. The main objectives of these FGDs were to understand the general problem relating to food security and how the households perceive the role of climate change on the changed situation. The results of the FGDs were utilized to broadly understand the changes in climate variables, crop production, frequency of natural disasters and food security at the district level. Along with the literature, the outcomes of the FGDs were considered while developing the questionnaire for the households' survey.

4.5. Type and Nature of Collected Data

Both quantitative and qualitative data were collected and analyzed for this study. The quantitative data were household size, family income and other sources of income besides agriculture. Qualitative data were the perception of households on climate change and changes in food availability, accessibility and their daily or economic activities. Some of the important points about the nature of the data are clarified as follows:

(a) The reported climate change experienced by the households (Figure 3) is for the past 20 years.
(b) Changes in crop production, food availability, accessibility, utilization and changes in daily or economic activities attributed to climate change are the average changes perceived by households in the past 20 years.
(c) Although perception of climate change may vary across the households, it still provides some strong evidence about the incidence of extreme events attributed to climate change and their

impacts on food security. Regardless of the limitations, perception-based data are useful for comparison with the findings of scientific research.

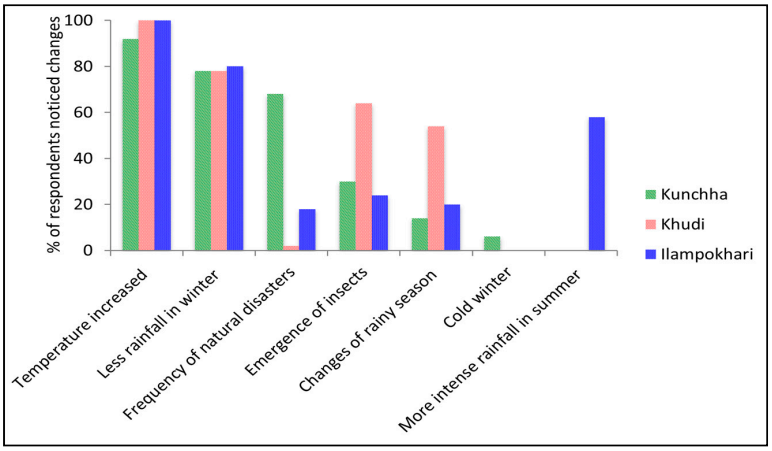

Figure 3. Local people's perception of climate change from Kunchha, Khudi and Ilampokhari village development committees (VDCs) of Lamjung.

5. Findings and Discussion

5.1. People's Perception of Climate Change

While doing the field-based household research to understand people perception of changes and responses to them, relying on science alone is not enough. The overview of how people see the changes regulates their reactions to them. The majority of the households in all three VDCs were familiar with the term "climate change", and they had experienced changes during the last two decades. Their experiences included increased temperature, changes in rainfall patterns, increasing frequency of natural disasters, emergence of insects, prolonged winter droughts and more intense rainfall in the summer. During the survey, households were asked to rank the changes in their areas in comparison with the last 20 years. Altogether, 97% of the respondents ranked increased temperature as Number 1, followed by less rainfall in winter (79%) and increased number of natural disasters (29%). A summary of the survey is presented in Figure 3 for each VDC, and a detailed analysis is presented in subsequent sections.

5.1.1. Precipitation

People's perception of changes in precipitation varied across the study areas. A majority of the respondents (79%) claimed that there was less rainfall in winter; 29% mentioned that there were some changes in quantity and duration; and 19% mentioned that the rainfall was more intense in summer. All of the respondents of the three VDCs had similar perceptions about the decreased rainfall during winter (December to February) and intense rainfall in summer (June to August). According to 14% of respondents in Kunchha, 54% in Khudi and 20% in Ilampokhari, the quantity and duration of the summer precipitation had changed, and rainfall was more intense in the summer. Similarly, 58% of the respondents from Ilampokhari reported more intense rainfall in summer, whereas no respondents reported more intense rainfall in summer from Kunchha and Khudi. The survey results match with the recorded precipitation at the respective stations (1980 to 2013). According to the observed precipitation record, Kunchha and Gharedhunga (Ilampokhari) showed increasing trends of precipitation, and Khudi showed a decreasing trend [40].

Local communities from the mountain region reported that there has been a significant decrease in the stream flow during the winter, which was not noticed in the past. The trend in the annual discharges of the Marsyangdhi and Khudi river basins indicates that the discharges in these major

basins are decreasing annually [41]. Khadka and Pathak [42] also found similar observations that natural springs in the mountain region, wells and water sources have dried up due to insufficient rainfall and variation in the precipitation patterns. The impact on water resources was found to be very high, which ultimately affects all sectors, such as agricultural production, drinking water supply, hydropower, water-induced disasters, forests and biodiversity. Anthropogenic activities, as well as climatic uncertainties in this region suggest that there will be more water stress in all sectors in the future during winter, as well as flooding, landslides and river bank erosion in summer. They also suggested that precipitation is likely to be more uncertain and that storm intensity will increase [43]. This changing precipitation pattern indicates that the drought period is becoming longer and the monsoon season is delayed. However, there was no definite trend in the annual precipitation amount [44]. More intense rainfall in summer may cause floods and landslides, which affect summer crops. Similarly, less rainfall in winter affects the winter crops and consequently changes the state of food security.

5.1.2. Temperature

In Lamjung, local people have been experiencing hotter weather in the last twenty years. Altogether, 97% of the respondents believed the temperature had increased. Among them, 92% of the respondents from Kunchha and 100% from Khudi and Ilampokhari mentioned hotter days in summer and longer warm days in winter in the last two decades. On the other hand, they mentioned that extremely cold days were also increasing during winter. As a result, the cropping patterns can be disturbed [45]. However, increased temperature has also been reported to have positive impacts, such as opportunities to plant fruit and vegetables at higher mountain elevations.

Consultation with local stakeholders in Lamjung district revealed that some plant species shifted to higher elevations, which might be due to increased temperature. A few respondents mentioned that they could grow some vegetables (tomatoes and cauliflowers) at higher altitude in recent years due to warming trends. These perceptions are supported by the historical records at Khudi station, which show that the minimum temperature increased 0.07 °C per year and the maximum temperature increased 0.02 °C per year from 1980 to 2012. Shrestha [46] reported a similar observation, that the mean annual temperature is estimated to increase by 0.06 °C annually and is projected to increase by another 1.2 °C by 2030, 1.7 °C by 2050 and 3.0 °C by 2100 in Nepal [47].

5.1.3. Frequency of Natural Disasters

Altogether, 29% of the respondents noticed both increased severity and frequency of natural disasters in the last twenty years. Among them, a higher percentage of the respondents (68%) were from Kunchha, followed by Ilampokhari (18%) and Khudi (2%). Most of the respondents reported increasing numbers of landslides at higher altitude and floods in the lowland. The government of Nepal has also ranked Lamjung district as the one most prone to landslides in the country [48]. The increasing numbers of natural disasters impose threats on people's lives and livelihoods.

5.1.4. Emergence of Insects

The emergence of new insects or increasing numbers of existing pests and diseases of crops and livestock was noticed by 39% of the respondents. Around 64% of the respondents from Khudi, 30% from Kunchha and 24% from Ilampokhari noticed increased numbers of existing insects and the appearance of new insects in their surroundings. Common insects and diseases mentioned included gabaro (stem borers) in maize, patero (rice bugs) in paddies, lie (aphids) on legumes and green vegetables and blight on winter crops. They believed that this was due to the increasing warming trend in the hilly regions. Particularly, households in Kunchha reported more damage to orange trees due to warming compared to the previous decade.

Due to the emergence of new diseases with increasing temperature, most of the orange trees were damaged, as shown in Figure 4. The remaining trees also have few fruits, and the taste is not as

good [49]. Most of the households reported that both quality and quantity of the orange decreased in comparison with the last twenty years. These changes directly impact their livelihoods since orange farming is the main source of income for some of the respondents. Most of the households reported that both the quality and quantity of the orange decreased in comparison with the last twenty years. These changes directly impact their livelihoods since orange farming is the main source of income for some of the respondents.

Figure 4. Damaged orange trees in Kunchha VDC of Lamjung.

5.2. Changes in Food Availability, Accessibility and Utilization

Food availability (production and distribution), access (affordability and location) and utilization are the core elements of food security. Climate change can affect these different dimensions of food security in various ways. To understand the household perception on changes in the dimensions of food security, the questionnaire was formulated in this way. In the first part of the questionnaire, household's general information, such as gender, age, education, occupation, average monthly income and related information was gathered. In the second part, the nature of income and the perception of climate change-related questionnaire was asked. Similarly, in the third part, the impact of climate change on dimensions of food security-related information was collected. A majority of the respondents (60%) reported decreased crop production in comparison to the last twenty years. The proportion of the respondents on decreased crop production varied across the three VDCs. Decreased crop production was reported by 78% of the respondents from Khudi, 58% from Ilampokhari and 44% from Kunchha. Altogether, 24% of the households reported increased crop production, and 15% reported unchanged production. Among the households with increased crop production, 54% were from Kunchha, 18% were from Khudi and 2% were from Ilampokhari. Among the unchanged households, 40% were from Ilampokhari, 4% were from Khudi and 2% were from Kunchha. The results are summarized in Figure 5.

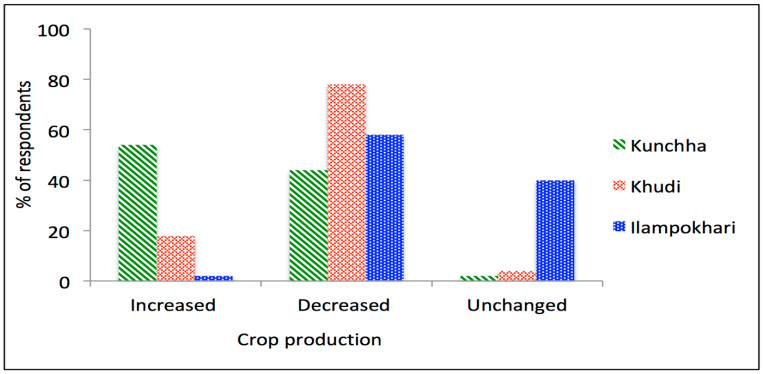

Figure 5. Percentage of respondents reporting changes in crop production from Kunchha, Khudi and Ilampokhari.

The majority of the households from Khudi and Ilampokhari perceived a decrement in crop production for the last twenty years. Regarding the changes in crop production within Kunchha, there was no uniformity among the households. Some of the households perceived an increase, whereas others perceived decrease. During the field visit, it was observed that households residing in the remote areas of Kunchha perceived crop production as decreased. Similarly, there is a diverse set of population; some are doing agricultural activities adopting new agro-equipment, fertilizers and inputs, while others are still at the subsistence level.

The agricultural sector is highly dependent on weather in this region, particularly precipitation. A majority of the farmers depend on rain-fed farming, which can be heavily affected by climate variability. Small changes in climate can induce large changes in agricultural risk in the mountainous region. Extreme weather conditions such as floods, droughts, frosts and hail could be disastrous for agricultural production. During the FGDs and KIIs, most of the participants mentioned delayed and shorter monsoon seasons, as well as high variability, long droughts, decreased winter rainfall and increased uncertainty, which have resulted in negative impacts on the production of both summer and winter crops. In addition to that, they mentioned about the remoteness of the villages, their limited development and economic opportunity, climate-induced natural disasters and poor resilience capacity against changing climate. According to the participants, the main causes of decreased food availability and accessibility were changes in weather patterns and the lack of youth in agriculture because of the increasing trend of out-migration.

Local communities reported one to two weeks of delay of the monsoon season and that it ends one week earlier, which affect both rice planting and harvesting. Additionally, upland farmers from the mid-mountain region were highly sensitive to the winter and pre-monsoon rainfall. Rain-fed crops like barley and winter vegetables are severely affected by low rainfall during winter and spring. MOAD [25] also reported that the delay in the monsoon and low rainfall resulted in only 70% to 80% of the paddy cultivation for the whole country in 2012. The households of Ilampokhari mentioned that unpredictable and untimely precipitation in recent years in the months of May and October resulted in considerable damage to several crops such as maize and rice at harvesting time.

During the survey, households were asked to rank the reasons or contributing factors for changes in crop production, providing each five options for increased and decreased production. If they had any other reasons, they were asked to write under another option provided in the question. Altogether, 66% of the respondents indicated the introduction of new seeds behind increasing crop production, and 58% indicated the use of fertilizer. Regarding the reasons behind decreased food production, 78% of the respondents indicated climate change, followed by less priority given to agriculture, abandoned land and lack of manpower. The rankings of all contributing factors in each VDC are presented in Table 2.

Regarding the crop production, the yield of barley (a staple food in the mountainous region of Nepal) decreased in the last 30 years [40]. This decrement was mirrored in the response of households from Khudi and Ilampokhari. The government of Nepal has started giving subsidies to farmers for different types of seed varieties, such as drought-tolerant wheat and flood-resistant rice, to minimize agricultural loss from extreme climate. Similarly, high-quality, fertilizer-responsive, improved maize seeds are targeted for mountainous farmers. This is reflected in the historical crop yield data of rice, maize and wheat, since the yield of these three crops increased in the last 30 years inLamjung district [40].

Table 2. Ranking of the reasons behind changes in crop production in Kunchha, Khudi and Ilampokhari.

Reasons	**Ranked by the Respondents**		
Production Increased	Kunchha	Khudi	Ilampokhari
a. Use of fertilizers	2	2	2
b. Introduction of new seeds	1	1	1
c. Irrigation facility	3	4	3

Table 2. *Cont.*

Reasons	Ranked by the Respondents		
d. Use of agro equipment	4	5	4
e. Others	5	3	5
Production Decreased			
a. Climate change	4	1	1
b. Fallow land	2	4	1
c. Less priority to Agriculture	1	2	3
d. Lack of manpower	3	3	2
e. Others	5	5	5

Ranking: 1 indicates high contribution, 5 indicates low contribution.

5.2.1. Changes in Food Availability

Food availability can be measured through production and the distribution of food to all people. It can be determined by local or national agricultural production and the ability to trade and transport essential food supplies from surplus areas to deficit areas. Regarding food availability, 34% of the respondents reported increased availability, 12% reported decreased availability and 54% reported unchanged availability in the last 20 years. A higher percentage of respondents from Kunchha (48%) reported increased food availability, while a higher percentage of respondents from Khudi (24%) reported decreased availability, and 54% of respondents from Ilampokhari reported unchanged availability (Figure 6).

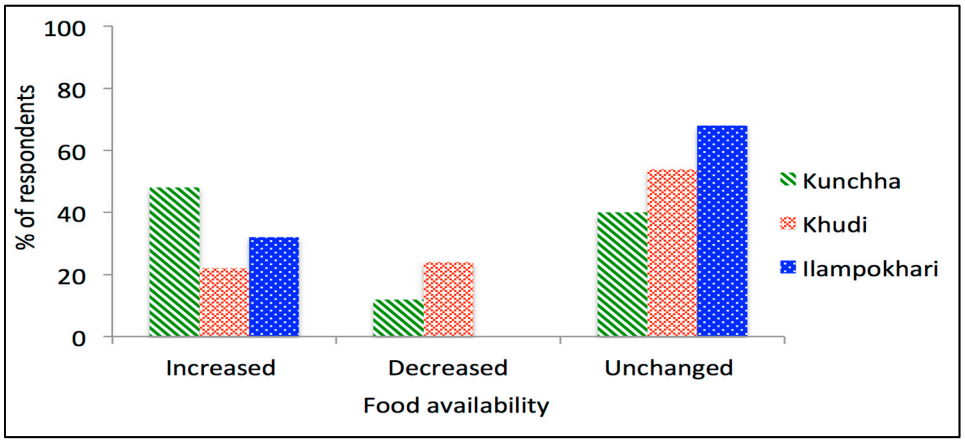

Figure 6. Percentage of household perceptions of changes in food availability in Kunchha, Khudi and Ilampokhari VDCs of Lamjung.

Among the changes in food availability households, the majority of the household perceived that the main contributing factors for increased food availability in Kunchha were increased crop production, increased income and access to road networks. In contrast, the reasons for decreased food availability in Khudi were decreased crop production and increased household burdens, such as family illness and diseases. No respondents from Ilampokhari noticed increased or decreased household burden in the last 20 years (Table 3). A majority of the households perceived a role of climate change in decreased crop production, decreased dairy production, increased food prices and increased household burden (Table 4).

Table 3. Underlying causes of changes in food availability.

Reasons of Changes in Food Availability	Percentage of Respondents		
	Kunchha (n = 30)	Khudi (n = 23)	Ilampokhari (n = 16)
Crop production increased	77	35	6
Crop production decreased	23	48	19
Income increased	97	39	87
Income decreased	3	13	0
Dairy product increased	87	9	6
Dairy product decreased	7	48	6
Food price increased	87	44	50
Food price decreased	0	4	0
Other household burden increased	6	35	0
Other household burden decreased	86	0	0

Note: Percentage is not 100% due to multiple responses. The figure in parenthesis is the numbers of respondents who chose the 'Yes' option in the previous question.

Table 4. Household perceptions of the role of climate change in changes in food availability from Kunchha, Khudi and Ilampokhari.

Reasons of Changes in Food Availability	Responses about Role of Climate Change (%)					
	Kunchha (n = 30)		Khudi (n = 23)		Ilampokhari (n = 16)	
	Yes	No	Yes	No	Yes	No
Crop production increased	21	79	100	0	100	0
Crop production decreased	71	29	100	0	100	0
Income increased	0	100	33	67	7	93
Income decreased	0	100	67	33	0	0
Dairy product increased	4	96	100	0	0	100
Dairy product decreased	100	0	55	45	100	0
Food price increased	8	92	90	10	100	0
Food price decreased	0	0	100	0	0	0
Other household burden increased	100	0	50	50	0	0
Other household burden decreased	0	100	0	0	0	0

5.2.2. Changes in Food Accessibility and Consumption

Food is allocated through markets and non-market distribution mechanisms. Factors that determine whether people have access to sufficient food through markets are considered in this section. These factors include distance of the food market from the homes and road access to reach the nearest market. Altogether, 50% of the respondents reported increased food accessibility; only 2% mentioned decreased accessibility and 48% indicated unchanged accessibility (Figure 7).

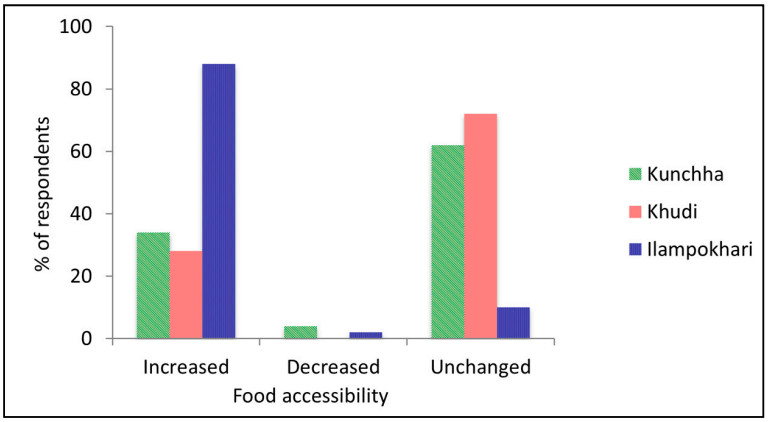

Figure 7. Percentages of household perceptions of changes in food accessibility in Kunchha, Khudi and Ilampokhari VDCs of Lamjung.

Food accessibility was measured through the distance from the local market and the time taken to reach it. In this case, 94% of the respondents reported that the distance of the local market had decreased with the development of roads, and 96% mentioned increased road access to reach the local market in the study area.

The development of road infrastructure in rural areas of Nepal has increased rapidly in the last twenty years, which has facilitated the transportation of food from surplus areas to deficit areas. Among the households with decreased food accessibility, only 1% mentioned that it was because of climate impacts (i.e., seasonal road disturbances by landslides and floods).

As for food consumption patterns, 70% of the respondents explained that it had improved, 3% mentioned deterioration and 27% mentioned it was unchanged for the last two decades (Figure 8). Households perceived that both quality and quantity of food improved.

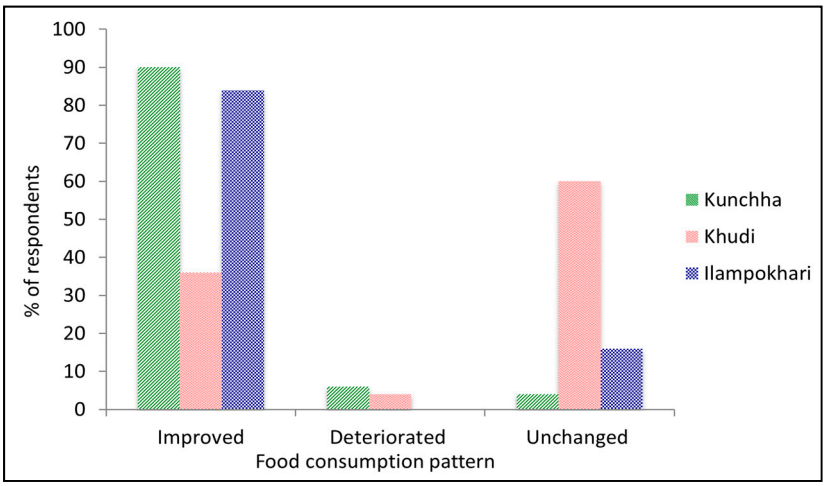

Figure 8. Percentage of household perceptions of changes in food consumption patterns in Kunchha, Khudi and Ilampokhari VDCs of Lamjung.

The reasons behind improved food consumption patterns were awareness about the consumption of food along with increased income and access to sources of nutritional food. Several local, national and international organizations are working in the sector of food security in Lamjung in collaboration with the government of Nepal. They provide training and awareness programs to the local people about hygiene and sanitation. This eventually helps with the consumption of nutritional food and enhances food security.

5.3. Changes in Households' Daily Activities

The results show that the daily activities of local people had changed in the last twenty years. A majority of the respondents (83%) reported that their daily activities were changed to ensure food security. Among the daily activities changed by households, 98% of the respondents mentioned that the time to collect and process food (seedling to harvesting) had increased due to climate change. As most of the agricultural land is rain-fed, changes in rainfall patterns affected crop cultivation patterns, as well. Most of the respondents witnessed the winter droughts of 2006, 2008 and 2009. They explained that food prices increased during that time and that they were in a difficult situation.

Increased time to collect fodder due to climate change impact was perceived by 78% of the respondents (Tables 5 and 6). The numbers in parenthesis reveal the numbers of households who chose the 'Yes' option in the previous question. They mentioned that there was no longer any grazing land and that it took a longer time to grow grass due to less rainfall and prolonged winter drought. Local species of grass disappeared in the study area due to warming. The time for collecting cooking fuel and household water was decreased in the study sites. Most of the local people have started to

buy firewood from the market or use biogas and liquefied petroleum gas for cooking in recent years with increasing income and lack of manpower to collect firewood from the forest.

Few respondents (5%) mentioned that the time increased for water collection. The reason is the use of pipelines to bring household water from main water resources rather than obtaining it by themselves. According to field observations, consultations with local stakeholders and a literature review, water resources have decreased in natural springs and streams flowing in the study area. However, it is very difficult to analyze the impact on water resources at the field level and whether this is due to climate change or anthropogenic activities, such as haphazard construction of rural roads by heavy excavators, deforestation, forest degradation or excess use of resources due to urbanization.

Table 5. Responses regarding changes in daily activities from Kunchha, Khudi and Ilampokhari.

Changes in Daily Activities	Percentages of Respondents		
	Kunchha (n = 50)	Khudi (n = 26)	Ilampokhari (n = 49)
Time to process food increased (from seedling to harvesting)	67	65	79
Time to process food decreased (from seedling to harvesting)	4	3	2
Time to earn money increased	33	69	35
Time to earn money decreased	0	4	6
Time to collect fodder for livestock increased	50	30	84
Time to collect fodder for livestock decreased	7	4	2
Time to collect cooking fuel increased	40	4	80
Time to collect cooking fuel decreased	4	4	8
Time to collect water increased	80	8	0
Time to collect water decreased	2	15	81

Note: Percentage is not 100% due to multiple responses.

Table 6. Household perception of the role of climate change in daily activities.

Changes in Daily Activities	Responses about Role of Climate Change (%)					
	Kunchha (n = 50)		Khudi (n = 26)		Ilampokhari (n = 49)	
	Yes	No	Yes	No	Yes	No
Time to process food increased (from seedling to harvesting)	67	33	100	0	100	0
Time to earn money increased	33	67	100	0	100	0
Time to collect fodder for livestock increased	50	50	100	0	85	15
Time to collect cooking fuel increased	40	60	0	100	71	29
Time to collect water increased	80	20	100	0	0	0

5.4. Changes in Households' Economic Activities and Livelihoods

Changes in lifestyles and economic activities of local people and their response to the impacts of climate change were also examined. Local people are involved in various types of economic activities for their livelihood, such as fruit farming, livestock rearing and agribusiness. About 41% of the respondents mentioned that their lifestyle and economic activities have changed in the last twenty years. The majority of the respondents from Kunchha (73%) mentioned decreased fruit farming, in contrast to Khudi (40%) and Ilampokhari (36%). Among them, 100% of the respondents from Ilampokhari and Khudi and 78% of the respondents from Kunchha perceived an impact of climate change on decreased fruit farming in the study sites (Tables 7 and 8). In Table 8, data not available reflect that the household did not choose these options because of multiple choices.

Migration increased heavily during the last twenty years. Altogether, 93% of the respondents mentioned increased migration for several reasons, such as study abroad, jobs and natural disasters. Among them, 73% of the migration was due to natural disasters, such as floods and landslides. According to a living standard survey of Nepal [7], 55% of households receive remittances from abroad, in contrast to 23% in 1995. There is no doubt that the inflow of remittances from migrants is a potential

source for improving local food security and livelihoods through increasing economic access to food and enhancing local small businesses for local skilled and unskilled labor. However, migration has also added challenges in the mountain areas. Increased migration and decreased interest by the youth in farming also add to low production in agriculture [2]. Households in all three VDCs face frequent labor shortages, which together with water shortages are leading to increased amounts of fallow agricultural land. This also imposes household burdens on women, children and elderly people, and it has exacerbated many social problems and family fragmentations.

Table 7. Responses regarding changes in economic activities and lifestyle in Kunchha, Khudi and Ilampokhari.

Changes in Economic Activities and Lifestyle	Percentage of Respondents		
	Kunchha (n = 50)	Khudi (n = 50)	Ilampokhari (n = 50)
Increased working hours on economic activities	66	35	64
Decreased working hours on economic activities	33	0	36
Increased family member migration	96	85	100
Decreased family member migration	3	0	0
Increased poultry farming	53	0	18
Decreased poultry farming	20	0	10
Increased fruit farming	13	0	0
Decreased fruit farming	73	40	36
Increased agribusiness	37	5	28
Decreased agribusiness	23	0	10
Increased livestock rearing	27	5	18
Decreased livestock rearing	27	5	0

Note: Percentage is not 100% due to multiple responses.

Table 8. Household perception of the role of climate change in changes in economic activities and lifestyle in Kunchha, Khudi and Ilampokhari.

Changes in Economic Activities and Lifestyle	Response about Role of Climate Change (%)					
	Kunchha (n = 50)		Khudi (n = 50)		Ilampokhari (n = 50)	
	Yes	No	Yes	No	Yes	No
Increased working hours on economic activities	20	80	86	14	86	14
Decreased working hours on economic activities	0	100			0	100
Increased family member migration	55	45	88	12	100	0
Decreased family member migration	0	100				
Increased poultry farming	12	87			0	100
Decreased poultry farming	83	17			100	0
Increased fruit farming	75	25				
Decreased fruit farming	78	27	100	0	100	0
Increased agribusiness	0	100	0	100	67	33
Decreased agribusiness	71	29			100	0
Increased livestock rearing	0	100	100	100	50	50
Decreased livestock rearing	75	25	0	0		

6. Adaptation to Climate Change

Climate variability has major impacts on lives and livelihoods. Households have adopted various practices to cope with the changing climate that strengthen their resilience. Some of them changed their profession from agriculture to other professions with changing climate. Changes in farming practices include water conservation methods, changes in sowing time and the introduction of new cash crops, such as black cardamom and coffee, which are more resilient to water stress and have higher market value [2]. Some of the households gave up rearing certain livestock.

Climate change has resulted in significant degradation of pastures and rangelands, which are free sources of grazing for livestock. Some of the households gave up planting crops, which were highly vulnerable to water stress. Some households introduced new crops on their farms. In Nepal,

farmers are shifting their cropping patterns from highly water-consuming crops (e.g., rice) to fruits and vegetables that are high-value crops [2,50]. Some of them started new off-farm income activities to support their food security and livelihoods because of high vulnerability to landslides and floods.

The majority (60%) of the respondents from Khudi, 38% from Kunchha and 22% from Ilampokhari changed their farming practices, changed professions from agriculture to others or changed from food crops to cash crops (Figure 9). Among the households that changed professions, 80% from Khudi, 57% from Kunchha and 90% from Ilampokhari perceived a role of climate change in changing profession (Figure 10). They mentioned that they were unable to feed their families while doing food crop agriculture, so they started cash crop agriculture. It helped to increase their income, and they could buy food from a nearby market. It is also reflected in the food accessibility of the households, with very few respondents reporting decreased food accessibility (only 2%).

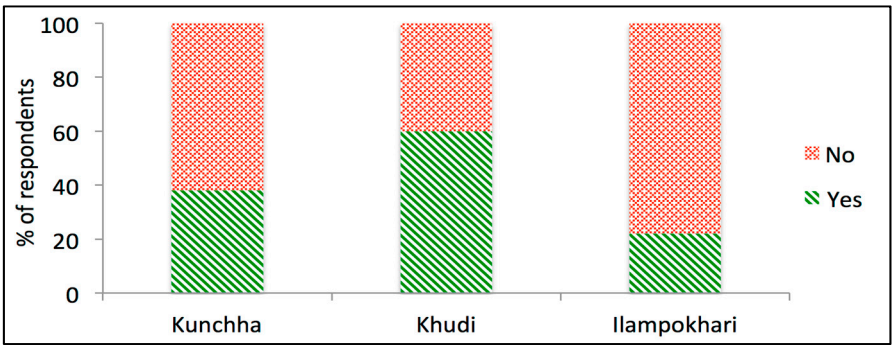

Figure 9. Households that changed profession in Kunchha, Khudi and Ilampokhari VDCs of Lamjung.

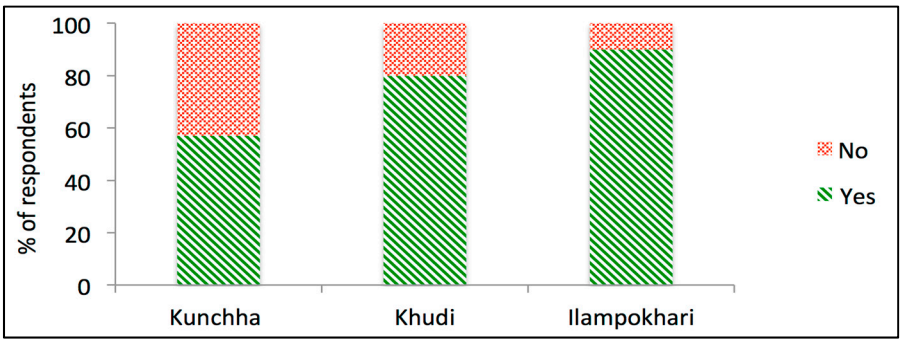

Figure 10. Respondents that changed profession due to climate impacts from Kunchha, Khudi and Ilampokhari VDC in Lamjung.

7. Discussion and Conclusions

A majority of the households experienced hotter days, less rainfall, droughts, floods and landslides for the last twenty years. They are well informed of the changing climate and its induced impacts on their food security. Local people have experienced the increased frequency of such extremities in recent years. The perception of climate change by households seems to relate to the direction in which climate variables actually change. The higher percentage of the households from Ilampokhari VDC perceived intense rainfall in summer when precipitation increased from 1980 to 2012 [40]. Similarly, the higher percentage of households from Khudi perceived drought where precipitation decreased from 1980 to 2012 [40]. The mountainous households do have varying levels of perception and attitudes towards climate change and its impacts.

Most of the respondents perceived the impact of climate change on decreased food production, decreased dairy production, food price and increased household burden. This study found that the overall food security of Khudi households was deteriorated in comparison with Ilampokhari and

Kunchha for the last twenty years due to decreased income, decreased crop production and deteriorated food consumption pattern. It is now widely recognized that rural mountainous households are most affected due to the extreme climate events because of the high dependency on natural resources.

Nowadays, remittances received from out-migrated, small businesses, wage labor, tourism and collection of medicinal plants and other herbs also contribute to livelihoods and food security. In the study areas, the households involved in other occupation besides agriculture perceived the improvement of their food availability, accessibility and consumption pattern. Additionally, the households residing near a road perceived increased crop production and increased food availability, because of easy access to the market to buy agricultural inputs and food in the food-lean seasons. The development of road infrastructure in rural areas of Nepal has increased rapidly in the last twenty years, which has facilitated the transportation of food from surplus areas to deficit areas.

The mountainous households already started autonomous adaptation practices to combat the changing climate. These include changes in farming practices, such as the use of fertilizer-responsive high-yielding crops, abandoning certain highly water-consuming crops and giving up rearing certain livestock, which are vulnerable to water and fodder stress. In addition, households invested in preparedness for climate-induced hazards, such as floods and landslides. Some of them took on new off-farm activities due to the increased vulnerability of agriculture and decided to migrate as an adaptation measure to find off-farm income opportunities.

During the focus group discussions, the participants proposed several potential options to ensure the food security, such as to provide subsidies to the farmers to attract the young generation to agriculture and to grab the opportunity of the changing climate by introducing new varieties, such as drought-resilient, high-yielding crop, the latest agro-equipment, etc. From the view of the study's findings, the following policies are suggested to minimize the impacts of climate change and to ensure the households' food security in the mountainous region of Nepal.

- Climate change has brought both opportunities and challenges for the mountainous households. It is crucial to enhance their understanding of risk related to climate change so that they are better prepared not only for the potential negative impacts, but also for taking advantage of any opportunity coming from climate change. For example, some of the households reported the production of cauliflower, tomatoes and cabbages in the higher altitudes that was not possible twenty years back. The national planning process should take into account such opportunities while preparing the adaptation plan in Lamjung.
- The Nepal government needs to identify specific zones for high value crops, such as fruits, cardamom, coffee, etc., since oranges are being damaged in Lamjung because of virus in recent years, which was one of the main sources of income for the households. Decreased orange farming has impacted the livelihoods of the mountainous households.
- The local and national government should invest in the development of infrastructure facilities, such as roads, markets and extension services, in partnership with private sectors [10]. Capitalizing on local resources and emerging opportunities will also help to control out-migration and the lack of manpower in the agricultural sector.

The Nepal government needs to establish different food security policies for the mountainous households based on the spatial variation because of the differential impact of climate change and the differential vulnerability of the households. There is also a need to make an amendment to climate change policies and agricultural policies under the projected changes in climatic conditions. Some policies seem to be inappropriate, e.g., the Nepalese government promotes the cultivation of rice and pulses in mountainous areas, although these crops are resource-intensive and very sensitive to water stress [10].

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References

1. IPCC (Intergovernmental Pannel on Climate Change). *Climate Change 2014. Impacts, Adaptation, and Vulnerability*; Part A: Global and sectoral aspects; Contribution of Working Group II to the Fifth Assessment Report; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2014.
2. Hussain, A.; Rasul, G.; Mahapatra, B.; Tuladhar, S. Household food security in the face of climate change in the Hindu-Kush Himalayan region. *Food Secur.* **2016**, *8*, 921–937. [CrossRef]
3. Mishra, B.; Babel, M.S.; Tripathi, N.K. Analysis of climatic variability and snow cover in the Kaligandaki River Basin, Himalaya, Nepal. *Theor. Appl. Climatol.* **2014**, *116*, 681–694. [CrossRef]
4. Parvin, G.A.; Ahsan, S.M.R. Impacts of climate change on food security of rural poor women in Bangladesh. *Manag. Environ. Qual.* **2013**, *24*, 802–814. [CrossRef]
5. Food and Agriculture Organization; International Fund for Agricultural Development; World Food Programme. *The State of Food Insecurity in the World 2013: The Multiple Dimensions of Food Security*; FAO: Rome, Italy, 2013; 56p.
6. Giribabu, M. Food and nutritional security in north east India: Some contemporary issues. *Int. J. Dev. Res.* **2013**, *3*, 1–8.
7. NDHS (Nepal Demographic and Health Survey). Population Division Ministry of Health and Population, Government of Nepal: Kathmandu Nepal, 2011. Available online: http://dhsprogram.com/pubs/pdf/FR257/FR257[13April2012].pdf (accessed on 10 December 2016).
8. FAO (Food and Agriculture Organization). *Climate Change and Food Security: A Framework Document*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2008.
9. Rasul, G. Food, water, and energy security in South Asia: A nexus perspective from the Hindu Kush Himalayan region. *Environ. Sci. Policy* **2014**, *39*, 35–48. [CrossRef]
10. Tiwari, K.R.; Balla, M.K.; Pokharel, R.K.; Rayamajhi, S. Climate change impact, adaptation practices and policy in Nepal Himalaya. In Proceedings of the Climate Change and Development Policy, Helsinki, Finland, 28–29 September 2012; United Nations University World Institute for Development Economics Research: Helsinki, Finland, 2012.
11. Suleri, A.Q.; Haq, S. *Food insecurity in Pakistan*; Settle, A., Salman, A., Franchis, L., Eds.; Swiss Agency for Development and Cooperation; Sustainable Development Policy Institute; World Food Programme Pakistan: Bern, Switzerland, 2009.
12. Bals, C.; Harmeling, S.; Windfuhr, M. Climate Change, Food Security and the Right to Adequate Food. Diakonisches Werk der Evangelischen Kirche in Deutschland. 2008. Available online: https://germanwatch.org/klima/climfood.htm (accessed on 10 December 2016).
13. FAO (Food and Agriculture Organization). Food Security: Concepts and Measurement. Rome Declaration and World Food Summit Plan of Action, Rome, 1996. Available online: www.fao.org/docrep/003/X8346E/x8346e02.htm#P1_10 (accessed on 15 November 2016).
14. Schmidhuber, J.; Tubiello, F.N. Global food security under climate change. *Proc. Natl. Acad. Sci. USA* **2007**, *104*, 19703–19708. [CrossRef] [PubMed]
15. Maplecroft, V. Climate Change Vulnerability Index 2009/2010. 2010. Available online: https://maplecroft.com/about/news/climate_change_risk_list_highlights_vulnerable_nations_and_safe_havens_05.html (accessed on 14 August 2015).
16. CRED (Center for Research on the Epidemiology of Disasters). Country profile: Natural Disasters—Nepal. 2016. Available online: http://www.emdat.be/country_profile/index.html (accessed on 27 September 2016).

17. Arnell, N.W.; Cannell, M.G.R.; Hulme, M.; Kovats, R.S.; Mitchell, J.F.B.; Nicholls, R.J.; Parry, M.L.; Livermore, M.T.J.; White, A. The consequences of CO_2 stabilisation for the impacts of climate change. *Clim. Chang.* **2002**, *53*, 413–446. [CrossRef]
18. Fischer, G.; Shah, M.; Van Velthuizen, H. *Climate Change and Agricultural Vulnerability*; International Institute for Applied System Analysis: Vienna, Austria, 2002.
19. Parry, M.L.; Rosenzweig, C.; Iglesias, A.; Livermore, M.; Fischer, G. Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Glob. Environ. Chang.* **2004**, *14*, 53–67. [CrossRef]
20. Bhatta, L.D.; van Oort, B.E.H.; Stork, N.E.; Baral, H. Ecosystem services and livelihoods in a changing climate: Understanding local adaptations in the Upper Koshi, Nepal. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.* **2015**, *11*, 145–155. [CrossRef]
21. Yang, Y.C.; Savitsky, A.; Alford, D.; Brown, C.; Wescoat, J.; Debowicz, D.; Robinson, S.Y. The Indus Basin of Pakistan. 2013. Available online: http://elibrary.worldbank.org/doi/book/10.1596/978-0-8213-9874-6 (accesed on 26 September 2016).
22. FAO (Food and Agriculture Organization). *The State of Food Insecurity in the World 2002. Food Insecurity: When People Must Live with Hunger, Fear and Starvation*; FAO: Rome, Italy, 2002.
23. Ghimire, D.R. Household food security and coping strategies: Vulnerabilities and capacities in rural communities. *Int. J. Sci. Res. Publ.* **2014**, *4*, 176.
24. Pant, K.P. Climate change and food security in Nepal. *J. Agric. Environ.* **2012**, *13*, 9–19. [CrossRef]
25. MOAD (Ministry of Agriculutral Development). *Statistical Information on Nepalese Agriculture 2011/2012*; Government of Nepal Ministry of Agricultural Development Agri-Business Promotion and Statistics Division Statistics Section Singha Durbar: Kathmandu, Nepal, 2013.
26. Malla, G. Climate change and its impact on nepalese agriculture. *J. Agric. Environ.* **2008**, *9*, 62–71. [CrossRef]
27. Regmi, B.R.; Adhikari, A. *Human Development Report; Country Case Study—Nepal*; Government of Nepal: Kathmandu, Nepal, 2007.
28. CBS (Central Bureau of Statistics). *National Accounts of Nepal 2012/13*; Central Bureau of Statistics, Government of Nepal: Kathmandu, Nepal, 2013.
29. CBS (Central Bureau of Statistics). *Metadata for National Agricultural Statistics in Nepal*; National Planning Commission Secretariat, Government of Nepal: Kathmandu, Nepal, 2007.
30. World Bank. World Development Indicators World DataBank. 2016. Available online: www.worldbank.org (accessed on 26 September 2016).
31. CBS (Central Bureau of Statistics). *Statistical Pocketbook*; Government of Nepal National Planning Commission Secretariat: Kathmandu, Nepal, 2014.
32. Regmi, H. Effect of unusual weather on cereal crop production and household food security. *J. Agric. Environ.* **2007**, *8*, 20–29. [CrossRef]
33. Shrestha, M. *Smallholders, Mountain Agriculture and Land Change in Lamjung District, Nepal*; The University of Georgia: Athens, GA, USA, 2007.
34. MoPE (Ministry of Population and Environment). *Initial National Communication to the Conference of the Parties of the United Nations Framework Convention on Climate Change*; Government of Nepal: Kathmandu, Nepal, 2004.
35. Dahal, N. Perceptions of Climate Change in the Himalayas. 2005. Available online: http://www.tiempocyberclimate.org/newswatch/feature050910.htm (accessed on 26 September 2016).
36. Brown, M.E.; Funk, C.C. *Food Security under climate Change*; University Nebraska: Lincoln, NE, USA, 2008; Volume 319, pp. 580–581.
37. Magawata, D. Information and communication technology: A variable tool for mitigating climate change and improving crop production. *Int. Lett. Nat. Sci.* **2014**, *18*, 53–62. [CrossRef]
38. Wlokas, H. The impacts of climate change on food security and health in southern Africa. *J. Energy S. Afr.* **2008**, *19*, 12–20.
39. Bellhouse, D.R. Systematic Sampling Methods. In *Wiley StatsRef: Statistics Reference Online*; John Wiley & Sons: New York, NY, USA, 2014. Available online: http://dx.doi.org/10.1002/9781118445112.stat05723 (accessed on 17 April 2017).
40. Poudel, S.; Shaw, R. The relationships between climate variability and crop yield in a Mountainous environment: A case study in Lamjung District, Nepal. *Climate* **2016**, *4*, 13. [CrossRef]

41. MOSTE (Ministry of Science, Technology and Environment). Nepal Climate Change Program (CCP) Results Management Framework (RMF) 2013–2020. 2014. Available online: http://fic.wharton.upenn.edu/fic/papers/15/p1510.html (accessed on 15 September 2016).
42. Khadka, D.; Pathak, D. Nepal climate change program (CCP) results management framework (RMF) 2013–2020. *Geoenviron. Disasters* **2016**, *3*, 15. [CrossRef]
43. NCVST (Nepal Climate Vulnerability Study Team). *Through the Eyes of the Vulnerability, Climate Change Induced Uncertainties and Nepal's Development Predicaments*; Government of Nepal: Kathmandu, Nepal, 2009.
44. WECS (Water and Energy Commission Secretariat). *Water Resources of Nepal in the Context of Climate Change*; Water and Energy Commission Secretariat (WECS): Kathmandu, Nepal, 2011. Available online: www.wec.gov.np (accessed on 11 September 2016).
45. Joshi, N.P.; Maharjan, K.L.; Piya, L.; Maharjan, N.P.; Lall, K.; Luni, P. Effect of climate yariables on Yield of major food-crops in Nepal. A Time-series analysis. *J. Contemp. India Stud. Space Soc. Hiroshima Univ.* **2011**, *1*, 19–26.
46. Shrestha, A.B.; Wake, C.P.; Mayewski, P.A.; Dibb, J.E. Maximum temperature trends in the Himalaya and its vicinity: An analysis based on temperature records from Nepal for the period 1971–94. *Int. J. Clim.* **1999**, *12*, 2775–2786. [CrossRef]
47. MoE (Ministry of Environment). *Climate Change Vulnerability Mapping for Nepal*; Government of Nepal: Kathmandu, Nepal, 2010.
48. NAPA (National Adaptation Programme of Action). *National Adaptation Programme of Action to Climate Change, Ministry of Environment*; Government of Nepal: Kathmandu, Nepal, 2010; pp. 1–96.
49. MOAC (Ministry of Agriculutre and Cooperatives). *Training Manual for Combating Citrus Decline Problem in Nepal*; Government of Nepal: Kathmandu, Nepal, 2011.
50. Gurung, G.B.; Bhandari, D. Integrated approach to climate change adaptation. *J. For. Livelihood* **2009**, *8*, 91–99.